

## PROPERTIES OF THE CENTRAL AMERICAN COLD SURGE

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## 1. INTRODUCTION

The Central American Cold Surge (CACS) is a frontal incursion from the United States into Central America and resembles the East Asian Cold Surge. They occur more frequently than analyzed by NMC or by published results, based on our observations between 1979 and 1990. Climatology and structure are quantified, based on surface and upper air stations throughout Central America, and satellite products from GOES (visible and infrared) and SSM/I (precipitable water and rain rate) satellite sensors.

## 2. CLIMATOLOGY

177 CACS were documented during October-March 1979-90 dry seasons. Approximately 13-14 events occurred in average

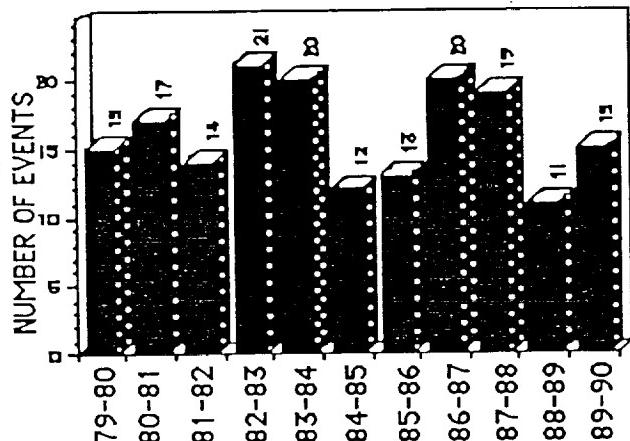


Fig. 1. Annual frequency of CACS events.

years, with about 20 events during each ENSO warm and cold phase. On average, the leading edge reaches  $12^{\circ}\text{N}$ , and is limited to an extreme penetration to  $7^{\circ}\text{N}$  by the Isthmus of Panama. The duration of CACS is about 5 d (northerly surface winds over the Gulf of Mexico), but most years have at least one event lasting 10 d.

## 3. STATION BEHAVIOR

Synthesized observations for 10 y at Central American stations show typical CACS behavior: Changes at Belize City: Daily max and min temperatures (5 and 2 K), dew point (5 K), pressure (5 mb), winds to northerly (speeds do not change, and diurnal variations weaken with passage), and frequency of ceilings from 25% before passage to 65% afterwards. Ceilings were typically 2500 to 3500 m before passage, lowering to about 1200 m afterwards. Daily precipitation increased to over 4 mm just before and after frontal passage (Fig. 2). CACS explained 50 and 90% of the dry season precipitation at Central American cities, with 90% typical.

Strong topographic and land/sea effects appear at individual stations. For example, at the mountain station of Tegucigalpa, Honduras ( $14^{\circ}\text{N}$ ), the maximum temperature may not decrease and the minimum temperature may actually increase, associated with a dew point temperature increase. Wind speeds increases substantially at Tegucigalpa and Guatemala City ( $14.3^{\circ}\text{N}$ ). Coastal cities on north facing coasts like LaMesa Honduras ( $15.3^{\circ}\text{N}$ ) experience more certain prolonged cloud ceiling and precipitation with CACS events. Temporal cross sections of station soundings do not resemble mid latitude frontal passages, due to air mass modification over the Gulf of Mexico and to the antecedent conditions of strong easterly trades south of the cold surge. A CACS which reached Belize City at 0000 GMT 20 November 1987 is fairly typical (Fig. 3). A high trade wind inversion appeared and strengthened near 650 mb about 24 h before the surface front arrived. With frontal passage northerly flow developed from the surface to about 500 mb, with isolated convection reaching to 300 mb. An inversion appeared at 400 mb, associated with convective tops. Within a day, this activity was replaced by a strong low level

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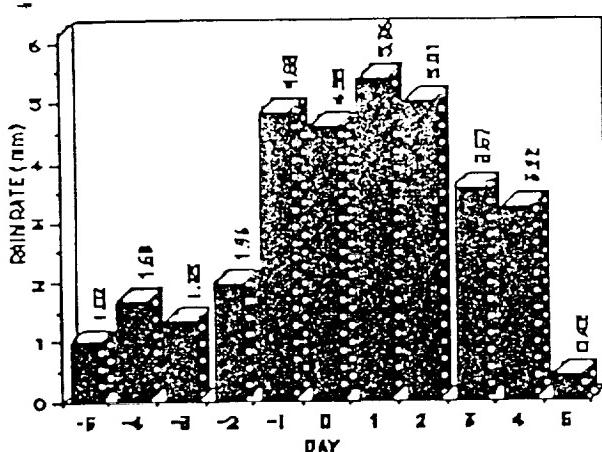


Fig. 2. Composite rain rate for 39 CACS events at Belize City.

inversion at 850 mb; easterlies did not reappear for several days. Often, convection does not appear at all. Frontal inversions at the surface almost never occur. Some events occur without inversions and some events, with inversion, exhibit no change in the inversion structure with frontal passage. Missing soundings are common during CACS.

#### 4. SATELLITE SPATIAL PATTERNS

Satellite imagery reveals significant cloud and moisture features. Ahead of the cold surge, the trades may turn southeasterly, and SSM/I imagery shows an increase in precipitable water to nearly 6 cm. This increase of 0.5-1.0 cm is not associated with a strengthening of the winds. Within the cold surge, precipitable water values decrease to less than 2 cm in the northern Gulf of Mexico and to less than 4 cm in the

Caribbean. SSM/I rainfall estimates seldom exceed 4 mm/h over the ocean and usually occur in a narrow band (less than 100 km wide) at the leading edge of the surge. Visible imagery delineates the surge with deep clouds at the leading edge, northwesterly cloud lines in the cold air, and a shift of coastal/orographic convection from eastward to northward facing coasts.

#### 5. CACS AND EACS COMPARISON

Events over Asia and over Central America are fundamentally the same. They are both triggered from large scale synoptic processes and both are commonly associated with explosive cyclogenesis off the continental coasts over warm oceanic currents. They both are defined in terms of temperature drops and wind shifts (freshening of the monsoons). Two primary differences occur: The CACS occurs considerably more frequently than its Asian counterpart. The CACS is much weaker, due to less difference between encroaching cold air mass and ambient tropical air mass. These differences lead to explosive convective development over the equatorial West Pacific, even into the southern hemisphere, as well as changes in convective cloud field and ceiling. Over the Caribbean, only ceiling changes and narrow regions of light precipitation are observed.

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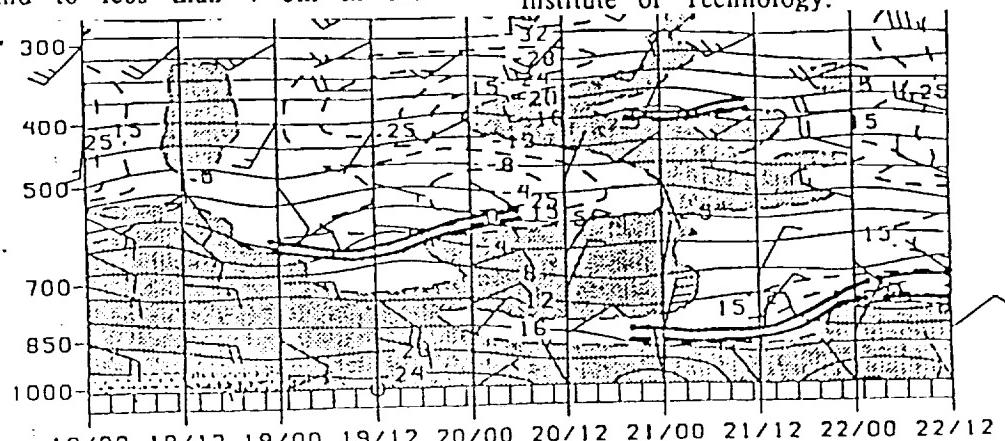


Fig. 3. Temporal cross section of soundings at Belize City from November 18 (left) to November 22 (right) 1987. Isotherms (solid) in 4 K increments, dew point depressions (dashed) at 5, 15 and 25 K, with less than 5 K shaded, and speed in kts. Heavy parallel lines are inversions.